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The Relationship Between Knowledge and Nutritional Intake With The Hand Muscle Strength of Karate Athletes at The Inkanas Dojo, South Sulawesi

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ABSTRACT

Hand muscle strength is a critical determinant of performance in karate, particularly in punching execution, gripping control, and stabilization during offensive and defensive movements. From a sports science perspective, muscular strength is influenced not only by training load and neuromuscular adaptation but also by nutritional factors, including dietary adequacy and nutritional literacy. This study aimed to analyze the relationship between nutritional knowledge and macronutrient intake with hand muscle strength among karate athletes at Dojo Inkanas, South Sulawesi. A quantitative correlational design with a cross-sectional approach was employed. The sample consisted of 20 adolescent athletes selected through total sampling. Nutritional knowledge was assessed using a structured questionnaire, while dietary intake was evaluated using a three-day 24-hour food recall. Hand muscle strength was measured using a calibrated hand dynamometer. The data were analyzed using the Chi-square test with a significance level of $p < 0.05$. The findings indicated that most athletes had low nutritional knowledge (65%) and insufficient hand muscle strength (55%). Bivariate analysis revealed no significant association between nutritional knowledge and hand muscle strength ($p = 0.957$). Similarly, energy, fat, and carbohydrate intake were not significantly related to hand muscle strength ($p > 0.05$). However, protein intake demonstrated a significant relationship with hand muscle strength ($p = 0.047$). These results highlight protein adequacy as the most relevant macronutrient associated with upper-limb strength performance in adolescent karate athletes.

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INTRODUCTION

Adolescence represents a critical transitional phase characterized by accelerated somatic growth, hormonal maturation, neuromuscular adaptation, and psychosocial restructuring. During this period, nutritional adequacy becomes a fundamental determinant of optimal physical development and long-term health outcomes (Wigati & Nisak, 2022; SKI, 2023). Adolescents are biologically vulnerable to nutrition-related

problems because rapid growth increases energy, protein, and micronutrient requirements. When this vulnerability intersects with high training loads in competitive sports, the risk of nutritional imbalance becomes more pronounced.

Adolescent athletes experience significantly greater metabolic demands than their non-athlete peers due to intensified training, competition stress, and recovery cycles (Buanasita, 2022). However, empirical findings consistently demonstrate that dietary intake among youth athletes frequently fails to meet Recommended Dietary Allowances (RDA). Puspita and Budiono (2023), in a study involving martial arts athletes, reported that 34% of respondents had very low energy and carbohydrate intake, 60% exhibited very low fat intake, and 34% showed insufficient protein intake. These deficiencies directly influence nutritional status and subsequently impair physical condition and performance capacity. National data further indicates that the prevalence of adolescent malnutrition in Indonesia reached 12.3%, with South Sulawesi reporting a higher prevalence of 17.8% (SKI, 2023). This condition signals a structural issue requiring scientific investigation, particularly among adolescent karate athletes who rely heavily on optimal physical conditioning.

Recent sports nutrition literature emphasizes that nutritional knowledge is a decisive behavioral determinant influencing dietary patterns, intake adequacy, and athletic performance outcomes (Wijaya et al., 2021; Meisarah & Mardiana, 2025). Athletes with higher nutrition literacy demonstrate more appropriate macronutrient distribution, improved hydration practices, and enhanced recovery strategies. Conceptually, nutritional knowledge operates through cognitive-behavioral pathways that shape food selection, portion control, and nutrient timing.

From a physiological perspective, adequate energy and protein intake supports muscle protein synthesis, neuromuscular coordination, and force production, particularly in sports requiring explosive and repetitive upper-limb actions. In karate, performance depends on strength, speed, endurance, flexibility, and agility (Bhakti & Satria, 2025). Among these components, hand and forearm muscle strength is critical because it underpins effective punching (tsuki), blocking, gripping, and impact stabilization. Hand muscle strength reflects the maximal contractile capacity of forearm flexor and extensor muscle groups, directly contributing to strike power and technical execution efficiency (Indrajaya, 2017).

Empirical evidence suggests that inadequate macronutrient intake compromises muscle glycogen availability, reduces force production, and impairs neuromuscular performance. Chronic energy deficiency may lead to decreased muscle mass, slower recovery, and increased fatigue risk (Buanasita, 2022). Thus, the interaction between nutritional knowledge, dietary intake, and muscular strength represents a multidimensional construct linking cognitive, behavioral, and physiological domains.

Although numerous studies have examined nutritional status among adolescent athletes, most investigations focus on body mass index (BMI), dietary recall patterns, or general performance indicators. Limited research has specifically analyzed the relationship between nutritional knowledge, actual nutrient intake, and objective muscle strength parameters in combat sports such as karate. Furthermore, previous studies often treat

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knowledge and intake as independent variables without integrating them into a single analytical framework assessing their combined influence on specific physical components.

In the context of South Sulawesi, empirical data examining karate athletes remains scarce, particularly at the dojo level. Existing regional statistics (SKI, 2023) highlight nutritional vulnerability among adolescents, yet sport-specific performance implications remain underexplored. There is also a conceptual gap in linking nutrition literacy with measurable muscular outcomes such as hand grip strength, which represents a functional and sport-relevant performance indicator. Therefore, a systematic examination of the relationship between knowledge, intake adequacy, and hand muscle strength in adolescent karate athletes is both theoretically justified and practically urgent.

This study aims to determine the relationship between nutritional knowledge and dietary intake with hand muscle strength among karate athletes at Dojo Inkanas, South Sulawesi. The study tests two hypotheses: (H_0) there is no significant relationship between nutritional knowledge and dietary intake with hand muscle strength; and (H_1) there is a significant relationship between nutritional knowledge and dietary intake with hand muscle strength.

The novelty of this research lies in its integrative analytical model that simultaneously examines cognitive (nutritional knowledge), behavioral (dietary intake), and physiological (hand muscle strength) variables within a specific martial arts context. Unlike previous studies that emphasize general nutritional status, this research focuses on a sport-specific physical component directly relevant to karate performance. By situating the investigation within a regional adolescent athlete population in South Sulawesi, this study also contributes context-specific empirical evidence to the growing discourse on youth sport nutrition in Indonesia. The findings are expected to inform evidence-based nutritional education programs, targeted dietary interventions, and performance optimization strategies tailored for adolescent karate athletes.

METHODS

This study employed a quantitative design with a descriptive correlational framework using a cross-sectional approach, which is widely recommended for examining associations between nutritional variables and physical performance indicators in adolescent athletes (Thomas et al., 2016; Jeukendrup, 2017; Burke et al., 2019). The cross-sectional model allows simultaneous measurement of exposure (nutritional knowledge and intake) and outcome (hand muscle strength) within a defined time frame, thereby providing efficient epidemiological insight into sport nutrition behavior and performance relationships (Spronk et al., 2014; Heaney et al., 2018).

The research was conducted on October 20–22, 2025, at Dojo Inkanas South Sulawesi, Makassar. The study population consisted of all karate athletes aged 13–18 years (n = 20). Total sampling was applied to minimize sampling bias and ensure full representation of the training cohort, as recommended in small athletic population studies (Mujika, 2018; Malina et al., 2015). Inclusion criteria include active training status,

age within adolescence, and willingness to participate through signed informed consent. Ethical procedures followed international standards for research involving minors and athletes (World Medical Association, 2013; Mountjoy et al., 2018).

Nutritional knowledge was assessed using a structured questionnaire consisting of 15 multiple-choice items based on the "My Plate" balanced nutrition guideline framework, which has been recognized as an effective educational model for adolescent dietary literacy (U.S. Department of Agriculture, 2020; Wijaya et al., 2021). Each correct response was scored 1 and incorrect responses 0, with total scores converted into percentages and categorized as insufficient (<56%), sufficient (56–75%), and good (76–100%). Nutrition literacy instruments have demonstrated predictive validity for dietary behavior and performance outcomes in youth athletes (Trakman et al., 2016; Meisarah & Mardiana, 2025).

Dietary intake was measured using a 3-day 24-hour food recall (two weekdays and one weekend day), a method considered reliable for estimating habitual intake in adolescent populations (Shim et al., 2014; Thompson & Subar, 2017). Reported food items were converted into household measures and grams, then analyzed using NutriSurvey 2007 software to estimate total energy, carbohydrate, protein, and fat intake. Macronutrient adequacy was interpreted relative to Indonesian RDA standards and sport nutrition recommendations for adolescent athletes (Buanasita, 2022; Puspita & Budiono, 2023). Multiple-day recall improves accuracy in capturing intra-individual dietary variation (Burrows et al., 2019).

Hand muscle strength was measured using a calibrated hand dynamometer, expressed in kilograms (kg). Grip strength assessment is widely accepted as a valid and reliable proxy of upper-limb muscular strength and functional performance in youth athletes (Wind et al., 2010; Ortega et al., 2015; Bohannon, 2019). Participants performed maximal voluntary contraction according to standardized positioning protocols to ensure measurement consistency. Anthropometric measurements (body weight and height) were obtained using a digital scale and microtoise to characterize sample profiles and control potential confounding influences related to growth status (Malina et al., 2015).

Data processing was conducted using Microsoft Excel and SPSS version 29. Univariate analysis described demographic characteristics, nutritional knowledge levels, macronutrient intake adequacy, and hand muscle strength using frequency distributions and central tendency statistics. Prior to inferential testing, normality and distribution patterns were examined. Bivariate analysis employed the Chi-square test to determine associations between categorical nutritional variables and categorical hand muscle strength levels, with statistical significance set at $p < 0.05$. The use of categorical association testing aligns with prior sport nutrition correlation studies examining dietary adequacy and strength performance indicators (Heaney et al., 2018; Burke et al., 2019).

This methodological framework integrates cognitive (knowledge), behavioral (dietary intake), and physiological (muscle strength) dimensions within a structured quantitative model, ensuring empirical rigor and contextual relevance for adolescent karate athletes in South Sulawesi.

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RESULTS AND DISCUSSION

Result

Table 1.
Gender of Karate Athletes at the Inkanas Dojo, South Sulawesi

Gender	n	%
Man	13	65
Woman	7	35
Total	**20**	**100**

Table 2.
Age of Karate Athletes at the Inkanas Dojo, South Sulawesi

Age	n	%
13	8	40
14	1	5
15	2	10
16	3	15
17	1	5
18	5	25
Total	**20**	**100**

Table 3.
Nutritional Knowledge Level of Karate Athletes at the Inkanas Dojo, South Sulawesi

Nutrition Knowledge Level	n	%
Not enough	13	65
Enough	6	30
Good	1	5
Total	**20**	**100**

Table 4.
Nutritional Intake of Karate Athletes at the Inkanas Dojo, South Sulawesi

Energy Intake	n	%
Not enough	4	20
Good	13	65
More	3	15
Total	**20**	**100**
Protein Intake	**n**	**%**
Not enough	7	35
Good	9	45
More	4	20
Total	**20**	**100**
Fat Intake	**n**	**%**
Not enough	9	45
Good	11	55
More	0	0
Total	**20**	**100**
Carbohydrate Intake	**n**	**%**

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Not enough	4	20
Good	14	70
More	2	10
Total	**20**	**100**

Table 5.
The Strength of Karate Athletes' Hand Muscles at the Inkanas Dojo, South Sulawesi

Hand Muscle Strength	n	%
Less than once	0	0
Not enough	11	55
Enough	3	15
Good	5	25
Very well	1	5
Total	**20**	**100**

Table 6.
The Relationship Between Nutritional Knowledge Level and Hand Muscle Strength of Karate Athletes at the Inkanas Dojo, South Sulawesi

Nutrition Knowledge Level	Hand Muscle Strength				Total	*p-value*
	Not Enough	Enough	Good	Good Very		
Not enough	7	2	3	1	**13**	
Enough	3	1	2	0	**6**	**0.957**
Good	1	0	0	0	**1**	
Total	**11**	**3**	**5**	**1**	**20**	

Table 7.
The Relationship Between Energy Intake and Hand Muscle Strength of Karate Athletes at the Inkanas Dojo, South Sulawesi

Energy Intake	Hand Muscle Strength				Total	*p-value*
	Not Enough	Enough	Good	Good Very		
Not enough	3	0	1	0	**4**	
Good	6	2	4	1	**13**	**0.772**
More	2	1	0	0	**3**	
Total	**11**	**3**	**5**	**1**	**20**	

Table 8.
The Relationship Between Protein Intake and Hand Muscle Strength of Karate Athletes at the Inkanas Dojo, South Sulawesi

Protein Intake	Hand Muscle Strength				Total	*p-value*
	Not Enough	Enough	Good	Good Very		
Not enough	3	0	4	0	**7**	
Good	5	3	1	0	**9**	**0.047**
More	3	0	0	1	**4**	
Total	**11**	**3**	**5**	**1**	**20**	

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Table 9.
The Relationship Between Fat Intake and Hand Muscle Strength of Karate Athletes at the Inkanas Dojo, South Sulawesi

Fat Intake	Hand Muscle Strength				Total	*p-value*
	Not enough	Enough	Good	Good Very		
Not enough	3	1	4	1	**9**	
Good	8	2	1	0	**11**	**0.154**
Total	**11**	**3**	**5**	**1**	**20**	

Table 10.
The Relationship Between Carbohydrate Intake and Hand Muscle Strength of Karate Athletes at the Inkanas Dojo, South Sulawesi

Carbohydrate Intake	Hand Muscle Strength				Total	*p-value*
	Not enough	Enough	Good	Good Very		
Not enough	3	0	1	0	**4**	
Good	6	3	4	1	**14**	**0.719**
More	2	0	0	0	**2**	
Total	**11**	**3**	**5**	**1**	**20**	

Discussion

Nutritional Knowledge and Hand Muscle Strength

The present study found no significant relationship between nutritional knowledge and hand muscle strength among karate athletes at Dojo Inkanas, South Sulawesi. Conceptually, nutritional knowledge represents a cognitive determinant shaping dietary attitudes and food-selection behavior (Trakman et al., 2016; Spronk et al., 2014). However, contemporary sports nutrition research emphasizes that knowledge alone does not automatically translate into behavioral compliance or physiological outcomes (Heaney et al., 2018; Bentley et al., 2021).

Empirical findings among adolescent athletes indicate that although nutritional literacy may be adequate, actual dietary practices often remain inconsistent due to environmental influences, peer norms, training schedules, and body image concerns (Burrows et al., 2017; Gacek, 2019). This behavioral gap explains why higher knowledge levels may not directly correlate with measurable strength outcomes. Muscle strength, particularly grip strength, is primarily influenced by neuromuscular adaptation, training specificity, and progressive overload mechanisms rather than cognitive awareness alone (Suchomel et al., 2016; Mujika, 2018).

Furthermore, adolescent athletes are in a dynamic growth phase, where hormonal status, maturation stage, and training age significantly influence strength development (Malina et al., 2015; Lloyd et al., 2016). Therefore, nutritional knowledge functions as a supportive factor but is insufficient as a standalone predictor of muscular performance.

Energy Intake and Hand Muscle Strength

The study also demonstrated no significant association between total energy intake and hand muscle strength. Physiologically, energy availability is essential to maintain

metabolic function, support training load, and prevent fatigue (Mountjoy et al., 2018; Burke et al., 2019). However, strength development depends more on resistance stimulus and neuromuscular recruitment than on caloric intake alone (Schoenfeld et al., 2017).

Research in youth athletes shows that adequate energy supports training sustainability but does not directly determine maximal force output (Thomas et al., 2016; Prado et al., 2021). Low energy availability can impair recovery and adaptation, yet sufficient energy without specific strength training does not guarantee increased muscular strength (Areta et al., 2014; Rahmawati et al., 2020).

Karate is characterized by explosive, intermittent movements requiring rapid motor unit activation. Grip strength performance therefore reflects neural drive efficiency and muscle fiber recruitment rather than caloric adequacy per se (Cormie et al., 2011; Suchomel et al., 2016). These findings align with sport performance models that position energy intake as a foundational requirement but not a direct determinant of strength capacity.

Protein Intake and Hand Muscle Strength

In contrast, a significant relationship was observed between protein intake and hand muscle strength. Protein plays a central role in muscle protein synthesis (MPS), repair of contractile proteins, and adaptation to mechanical loading (Phillips & Van Loon, 2011; Morton et al., 2018). Adequate protein intake enhances hypertrophic response and supports strength gains when combined with resistance or sport-specific training (Schoenfeld et al., 2017; Jäger et al., 2017).

Among adolescent athletes, optimal protein distribution throughout the day has been associated with improved lean mass development and neuromuscular performance (Areta et al., 2014; Moore et al., 2015). Although strength is multifactorial, evidence consistently demonstrates that insufficient protein adaptation limits to training stimuli (Morton et al., 2018).

Karate athletes rely on upper-limb force production for punching and blocking techniques. Therefore, adequate protein availability may facilitate structural muscle adaptation and improved contractile efficiency. However, it must be emphasized that protein acts synergistically with training load; without progressive overload, increased intake alone does not substantially enhance strength (Phillips, 2016). The present findings reinforce protein's role as a critical nutritional component within the muscle adaptation system.

Fat Intake and Hand Muscle Strength

No significant association was found between fat intake and hand muscle strength. Fat primarily functions as a long-term energy substrate and facilitates absorption of fat-soluble vitamins (Jeukendrup, 2017; Burke et al., 2019). While essential for hormonal balance and overall health, its direct contribution to maximal strength output is limited.

Studies in adolescent and combat-sport athletes report that fat intake variations do not significantly influence grip strength or short-duration explosive performance (Prado et al., 2021; Mustika & Dewi, 2021). Instead, muscle mass, neural activation, and protein adequacy are more dominant determinants (Schoenfeld et al., 2017). Thus, fat intake supports systemic energy balance rather than directly modulating muscular force production.

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Carbohydrate Intake and Hand Muscle Strength

Similarly, carbohydrate intake showed no significant relationship with hand muscle strength. Carbohydrates are the primary substrate for maintaining glycogen stores and supporting moderate-to-high intensity activity (Burke et al., 2019; Thomas et al., 2016). However, glycogen availability primarily influences endurance capacity and repeated sprint performance rather than maximal isometric grip strength (Impey et al., 2018).

In intermittent sports like karate, carbohydrates help sustain training volume and delay fatigue, yet strength output depends more on neuromuscular adaptation and structural muscle development (Cormie et al., 2011; Suchomel et al., 2016). Therefore, carbohydrate adequacy enhances performance sustainability but does not independently predict upper-limb strength.

Overall Interpretation

Collectively, these findings suggest that hand muscle strength in adolescent karate athletes is a multifactorial outcome shaped by the interaction of training stimulus, neuromuscular adaptation, maturation status, and specific nutrient adequacy—particularly protein. Nutritional knowledge and total energy intake serve as foundational components but do not independently determine strength performance. This supports contemporary sport science frameworks emphasizing integrated training–nutrition models for youth athlete development (Mountjoy et al., 2018; Burke et al., 2019; Lloyd et al., 2016).

CONCLUSION

This study concludes that the level of nutritional knowledge among karate athletes at the Inkanas Dojo, South Sulawesi, remains predominantly in the low category, indicating limited understanding of balanced nutrition principles such as the “My Plate” guideline. However, despite this limited knowledge, most athletes demonstrated generally adequate intake of energy, protein, fat, and carbohydrates. However, this adequacy was not fully reflected in their hand muscle strength profile, which was largely categorized as insufficient.

Bivariate analysis revealed no significant association between nutritional knowledge and hand muscle strength, suggesting that cognitive understanding alone does not directly translate into physiological performance outcomes. Likewise, total energy, fat, and carbohydrate intake were not significantly related to hand muscle strength, reinforcing the concept that muscular strength is more strongly influenced by neuromuscular adaptation, training specificity, and mechanical load than by caloric sufficiency alone.

Conversely, protein intake showed a significant relationship with hand muscle strength, confirming its critical role in muscle protein synthesis, repair, and structural adaptation. These findings highlight that while overall dietary adequacy is important, protein intake represents the most relevant macronutrient associated with upper-limb strength performance in adolescent karate athletes.

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